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Mine-hunting software helping doctors to identify rare cells in human cancer

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Medical researchers are demonstrating that Office of Naval Research (ONR)-funded software developed for finding and recognizing undersea mines can help doctors identify and classify cancer-related cells.

"The results are spectacular," said Dr. Larry Carin, professor at Duke University and developer of the technology. "This could be a game changer for medical research."

The problem that physicians encounter in analyzing images of human cells is surprisingly similar to the Navy's challenge of finding undersea mines.

When examining tissue samples, doctors must sift through hundreds of microscopic images containing millions of cells. To pinpoint specific cells of interest, they use an automated image analysis software toolkit called FARSIGHT, or Fluorescence Association Rules for Quantitative Insight. Funded by the National Institutes of Health (NIH) and the Defense Advanced Research Projects Agency (DARPA), FARSIGHT identifies cells based upon a subset of examples initially labeled by a physician. But the resulting classifications can be erroneous because the computer applies tags based on the small sampling.

By adding ONR's active learning software algorithms, the identification of cells is more accurate and FARSIGHT's performance more consistent, researchers said. The enhanced toolkit also requires physicians to label fewer cell samples because the algorithm

automatically selects the best set of examples to teach the software.

"This is not a typical Navy transition," said Carin. "But it is a transition to a very important medical tool used literally at hospitals around the world. There is a real chance this may save lives in the future."

A medical team at the University of Pennsylvania is applying the ONR algorithms, embedded into FARSIGHT, to examine tumors from kidney cancer patients. Focusing on endothelial cells that form the blood vessels that supply the tumors with oxygen and nutrients, the research could one day improve drug treatments for different types of kidney cancer, also known as renal cell carcinoma.

"With the computer program having learned to pick out an endothelial cell, we have now automated this process, and it seems to be highly accurate," said Dr. William Lee, an associate professor of medicine, hematology and oncology at the university who is leading the research effort. "We can begin to study the endothelial cells of human cancer -- something that is not being done because it's so difficult and time-consuming to do."

It usually takes days, even weeks, for a pathologist to manually pick out all the endothelial cells in 100 images. The enhanced FARSIGHT toolkit can accomplish the same feat in a few hours with human accuracy.

"This is an important NIH-funded clinical study that we're supporting with FARSIGHT, and Dr. Carin's active learning system has been a great success," said Dr. Badri Roysam, an electrical and computer engineering professor at the University of Houston and program investigator for FARSIGHT.

ONR's active learning software was originally developed to allow robotic mine-hunting systems to behave more like humans when they are

uncertain about how to classify an object. Using information theory, the software asks a human to provide labels for those items. This feature is valuable in mine warfare, where identifying unknown objects beneath the ocean has been accomplished traditionally by sending in divers.

"This is dangerous and is exactly what we're trying to eliminate," said Dr. Jason Stack, the program officer at ONR who funded Carin's research. "Developing unmanned systems that are not only autonomous but can also continuously learn from the warfighters employing them is core to our strategy. It speeds up mine countermeasures and helps get the man out of the minefield."

Provided by Office of Naval Research